

Banggai Cardinalfish Status Review Report: ID267

Peer Review Comments

We solicited review of the Status Review Report from five potential reviewers. Three people agreed to be reviewers and provided reviews. Reviewer comments are compiled below from comments on drafts of the manuscript and are not in the order of the reviewer identification list below.

Reviewers (listed alphabetically):

Ms. Abigail Moore
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Comments in Response to Peer Review Charge

1. In general, does the Status Review include and cite the best scientific and commercial information available on the species, their biology, population structure, habitats, threats, and risks of extinction?

Reviewer #1¹: I consider that the review team has done a commendably thorough review, based on the search criteria stated. I have made some suggestions for minor revision and some factual corrections (see coloured text). I have also given some additional information in footnotes (both in Part B), and in the notes below. These may or may not be worth incorporating in some fashion. I attach two documents referred to in the footnotes. One document is in English and available on the internet while the other (in Indonesian) contains relevant recent data and is still in press, therefore not generally available as yet. Although

¹ Reviewer number does not correspond to alphabetically listed peer reviewers.

these can add some relevant details, they do not contain data or information which should substantially change the overarching conclusions drawn.

Reviewer #2: In this section I consider that the review has covered the literature available via the methods mentioned and some additional sources and in the main provides a good overview of current knowledge and opinions. There was at least one reference which was referred to but not listed in the references, which I am providing now... My remarks below are set out under the main points covered in the review, giving the page numbers from the original manuscript provided for review (not this file).

Reviewer #3: No specific answer. See specific editorial comments below.

2. Are the scientific conclusions factually supported, sound, and logical?

Reviewer #1: In general yes. I have suggested a few changes and provided footnotes in the final sections of Part II (from Assessment of significant portion of its range and assessment of extinction risk section to the end) to indicate which points I fully agree with and to address points where I consider that the conclusions are incomplete or may be open to doubt, and to make a few adjustments based on the best of my knowledge. See also notes below.

Reviewer #2: Mostly, I consider this a fair and balanced summary, and fully agree with the moderate risk assessment. I would like to make a couple of points.

- I question the statement about stabilised population in the waters of Bone Baru village. Within the MPA Banggai cardinalfish are more abundant than in the so-called "pristine" (unfished would be a better term) pearl farm. However this is not only due to protection or to the status of the habitat/micro-habitat but to replenishment, within and without the MPA, by rejects from the trade and by fish confiscated from traders in violation of the quota. Such a situation can hardly be called stabilised.
- It is noteworthy that a small coral restoration effort just outside the MPA is always very densely inhabited by Banggai cardinalfish, showing the potential for habitat restoration to promote population recovery at suitable sites. We have never seen recruits in these corals, but there are usually many in the nearby sea anemones, and it is very likely that the habitats work in synergy. The increased harvest of sea urchins and sea anemones is not in the future, it has already happened. It seems to have begun around 2007 and accelerated since around 2010. I suggest the words "in the future" be deleted.
- I disagree with "likely resulted in a 90% decrease..". I would suggest "has resulted in a marked decrease", as there has definitely been a decline but the 90% figure is controversial and highly unlikely.
- The BCF-RA has come to an end. It should be noted that a follow-up (e.g. under the CTI-CFF) will be vital to maintain and further the advances made.

- I disagree that the delegation to regional governments is the reason for the slow implementation. There are general rules for the coastal, marine and small islands areas, for the movement of fall fisheries produce, etc, most of which are indeed poorly or not implemented, one reason being a chronic lack of funds for logistics. There are no specific rules or regulations except for the BCF quota, which is local/regional and only has teeth because of the local Fish Quarantine branch policy.
- This aquaculture initiative in Thailand is not good news for Indonesia or the Banggai cardinalfish. The social and political ramifications are likely to be negative. The Banggai cardinalfish has the potential to become a flagship species for this relatively remote area with high levels of poverty, and national pride is also involved. I would be happy to discuss this matter further and how some form of aquaculture, e.g. the "in situ" concept, could play a positive role.

Reviewer #3: The reviewer disagrees with the results of the extinction risk assessment of *Pterapogon kauderni* presented in the Draft Status Review Report. It is the reviewer opinion that it should be "High" not "Moderate".

a) *Qualitative Risk Analysis of Demographics.* It is not evident to the reviewer how after evaluating the summarized information, it was concluded that in considering its demographic risks, *P. kauderni* is at a moderate risk of extinction. The reviewer's opinion is that if the analysis follows the examples of qualitative reference levels mentioned in assessment, the level of extinction risk, considering demographics, should be High, not Moderate. The reviewer's opinion is that a high risk level is a more accurate assessment for a species that presents:

- 1) Very low fecundity (in fact, the lowest in Apogonidae), and reduced fertility.
- 2) Advanced parental care with high energy investment per offspring;
- 3) Extended incubation period (long embryonic development and incubation of post-hatched juveniles) that greatly constrains the males' number of reproductive cycles and their availability for mature females, leading to sex-role reversal.
- 4) Absence of dispersal mechanisms throughout its entire life cycle, leading to its high level of population discreteness and exposed to catastrophic stochastic events.
- 5) An estimated ~90% of mortality after the first two weeks post-recruitment.
- 6) An extremely reduced geographic distribution formed by disconnected populations and without any meaningful migration capacity, which would restrict the species to the present distribution, even in the unlikely event that its capture comes to an end.
- 7) The species has suffered ~ 90% decline in abundance and significant reduction in densities in many populations, exposing them to a number of compensatory processes, and continues to be harvested without any effective regulations or quotas.
- 8) This species is an obligated commensal with various invertebrate hosts, which are increasingly being harvested for human consumption. Anemones and seachins possess a given maximum "carry capacity". Thus, it seems logical to assume that in areas where

those substrates are harvested, group size and abundance of *P. kauderni* will be significantly affected, even without being targeted itself for collection.

b) *Threats Assessment. Section.* It is not clear to the reviewer how “a 90% decrease in in the population density since the early to mid-1990s”, can be assessed as a moderate risk of extinction due to overutilization. What % of the species abundance decrease and DPS extirpations would be required for *P. kauderni* to be assessed at a high risk? In fact, a moderate risk of extinction seems to contradict the statement: “the loss of populations within the natural range of the Banggai Archipelago would contribute significantly to the species’ risk of extinction, whether now or in the foreseeable future throughout all of its range”, which is supported by the mentioned dramatic decline and the proved extirpation of several populations. Thus, is the reviewer’s opinion, that high risk is the most appropriate level of risk of extinction that *P. kauderni* is facing due to various threats, including overexploitation and habitat/ critical substrate degradation.

c) *Overall Extinction Risk—Synthesis and Finding. Section.* If the overall extinction risk assessment of *P. kauderni* follows: 1. the criteria/guidelines of ESA section 4 as described in the assessment of extinction risk; 2. the “Qualitative ‘Reference levels’ of relative Extinction Risk” as described in Table 2; and, if this assessment is based on the biological and conservation status information summarized in this Draft Status Review Report, then, it is the reviewer’s opinion that the Extinction Risk of *P. kauderni* clearly should be High, not Moderate. A species that (1) has been already assessed by the IUCN as Endangered; (2) has suffered a ~90% reduction in abundance (due, principally, to the overexploitation for the aquarium trade in a decade’s period); (3) possess an extreme spatial structure with virtually no connectivity (as demonstrated by its unparalleled high degree of genetic differentiation among populations); and (4) whose persistence is undoubtedly in question (as evidenced by the extirpations of populations already occurred, affecting a significant portion of its range [SPR], seems to fit exactly the definition of High Risk provided in Table 2. In addition, demographic risks of *P. kauderni* are influenced by both compensatory processes (intimately related to its reproductive biology, including pair formation, sex role reversal, Allee effects), as well as stochastic catastrophic processes. The latter include both of natural origin (such as significant habitat destruction by earthquakes/tsunamis, Niño events, etc.) and anthropogenic, e.g., ongoing and widespread habitat/substrate degradation by destructive fishing, pollution, coral mining, unregulated and increasing removal of critical living substrates (particularly anemones). Finally, *P. kauderni* undoubtedly faces clear and present threats as exemplified in Table 2. As it was described in this Draft, this species is restricted to 34 islands (possible less today), 21 of which are < 6 km in length, with a total area of occupancy of just ~30 km². This area is calculated by assuming an uninterrupted presence of *P. kauderni* along the islands inhabitable margin. Thus, this is the maximum available area for the species, and it is certainly an overestimation since none of islands in which *P.*

kauderni inhabits possess a continuous suitable habitat. Moreover, as mentioned above, the species' habitat has been under rampant destruction/ modification, with no diminishing prospects for the foreseeable future. In fact, all indicates that the unregulated coral mining will continue to increase, as new roads, piers, and houses continue to be built on the larger islands.

In summary, it is difficult to find a descriptor in the High Risk level of Table 2 that does not characterize *P. kauderni* situation. Even a disease is increasingly exacerbating its extinction risk given the high mortality rate of imported specimens contracting a *Megalocytivirus* virus during the commercialization process, which triggers a higher capture volume to satisfy the importation demand.

3. Where available, are opposing scientific studies or theories acknowledged and discussed?

Reviewer #1: Mostly. I am extremely concerned about the point on aquaculture, e.g. in Thailand. Captive breeding outside the endemic distribution will not benefit the Banggai people, especially the fishermen or the key decision-makers at community and government level. It is very unlikely Banggai cardinalfish could be produced cheaper than wild caught, and the logistics (on-site, e.g. electricity, equipment and supplies as well as distribution) make it unrealistic to promote conventional ex-situ breeding in the Banggai Archipelago except possibly if eco-tourism or a premium niche market were to be developed. Indeed the current breeding initiatives supported by CSR of the petroleum company operating in the Gulf of Tolo may benefit the species but from a human point of view will benefit communities on the Sulawesi mainland, not the people in the Banggai cardinalfish endemic distribution.

Aquaculture for conservation (e.g. re-stocking) would need to consider the genetic diversity patterns (to maintain genetic diversity and any possible specific fitness adaptations, broodstock would have to be from the proposed re-stocking site – i.e. separate broodstock for each site at a very fine scale) as well as concerns such as health (e.g. risk of introducing or activating the iridovirus or other diseases) and behaviour (e.g. adaptation to selecting/catching wild prey and predator avoidance). For attempts to re-introduce extirpated populations, the nearest possible stock should be used. Indeed, throughout the trade also there should be efforts to reduce/control the release of fish outside their site of origin, with the possible exception of sites where genetic mixing has already taken place for years (e.g. Bone Baru), and which have already become irreversibly mixed and lost their identity from a genetic point of view.

With respect to the promotion of aquaculture, I consider that one option with considerable potential for ecological and socio-economic benefits would be a kind of semi-wild "in-situ breeding" by the current fishing communities in the endemic area. This could be implemented through maintaining "BCF gardens" with abundant microhabitat and measures

to improve recruit survival (effectively mini MPAs with a special focus). Another approach, as an alternative or better still as a complementary activity, would be to use low-tech extensive semi-natural breeding set-ups similar to that used at the experimental station on Ambon, combined with direct links to overseas buyers. Both of these would provide opportunities for research as well as conservation and community benefits.

It is clear that effective and holistic resource management, including regulation of the fishery and trade could provide many benefits and improve the conservation outlook for this species. If the (legal) trade is stopped with no other benefit from the Banggai cardinalfish to replace it, it is doubtful whether this will promote conservation.

In the latter scenario, it is exceedingly unlikely that anyone in Indonesia with any power at grass roots or government levels is going to care what happens to the Banggai cardinalfish, unless (i) it can be given a different value, e.g. through eco-tourism, or (ii) there is significant pressure from outside or from above at the relevant levels. The threats which are now moderate will undoubtedly become more severe and accelerated loss of habitat/microhabitat alone is very likely to lead to serial extirpation. No-one will care to even think about regulating loss of microhabitat if the Banggai cardinalfish is no longer of economic value. Current efforts, however limited (e.g. Bone Baru villagers trying to prevent the collection of sea urchins in their waters) will most likely cease sooner rather than later.

Indeed, if the habitat/micro-habitat issues are not addressed, I predict that the current moderate threat level, which I consider correct at this time, will swiftly become high. Local extirpations will increase in frequency with the loss of entire genetic lineages, and the best we could hope for long-term would be for a few remnant populations to survive in serendipitous refugia. These would of course be increasingly vulnerable to stochastic events, including climate change related phenomena.

Reviewer #2: No specific answer. See specific editorial comments below.

Reviewer #3: No specific answer. See specific editorial comments below.

4. Are uncertainties assessed and clearly stated?

Reviewer #1: Mostly. Some remarks in the text, footnotes and notes below.

Reviewer #2: No specific answer. See specific editorial comments below.

Reviewer #3: No specific answer. See specific editorial comments below.

Editorial Comments

Reviewer #1:

Page 4. Add ‘embryo develops directly into a juvenile. Also, sex roles are reversed in that males provide parental care of the offspring.’ Add. ‘on average’ regarding sexual dimorphism. “However there was high variability between individuals and overlap with females in the sample.”

Page 4. Ref. age to maturity: “Our observations indicate that the age at maturity is very variable, from around 7 months to over one year depending on conditions. There are indications of between-site variability. However I would agree that the 9-12 months given above should cover the majority of individuals.”

Page 4. Ref. generation length: “I would estimate this to be somewhere between 1.5 and 2 years. Definitely more than one year.”

Page 4. Ref. life span: “This estimate of potential life span is a maximum, excluding predation and other causes of early mortality”

Page 4. Ref. mouthbrooding: “Paternal mouthbrooding is a general trait of the cardinalfishes, Family Apogonidae. The unusual feature in *P. kauderni* is the extended brooding of larvae after hatching, resulting in the release of fully-formed juveniles or recruits, which has been referred to as paternal mouth brooding with direct development. However the egg-embryo-larva-juvenile process is normal, no stages are skipped as seems inferred by the way this is written. The processes just happen in the male's buccal pouch rather than during a free-swimming or floating (usually planktonic) stage as in most fishes.”

Page 5. Add ‘There is some evidence that fecundity may be positively correlated with female size (Ndobe et al. in press).’ “Our recent study (funded by a small grant from the Indonesian Higher education Department) shows a positive correlation for egg number with female size ($P < 0.05$). We did not measure the eggs. The graph is shown in the attached Indonesian article (in press).”

Page 5. Ref. average male incubation: ‘We have very rarely observed numbers this low in fish sampled from the wild, which average around 55-60; the samples in Ndobe et al. 2013, gave an average of 59

Page 5. Ref. fecundity: “Based on our most recent study which covered not only sex ratio but an initial estimation of operational sex ratio (article in preparation), I would say that this is about

right, based on 2 years average, 4-5 times successful breeding per year and fecundity/fertility of around 60. In favourable conditions however the number of offspring produced and survival rates could be higher. Indeed improved management of the habitat and fishery/trade could substantially increase recruit survival. However 5-10% of 500 is 25-50 offspring reaching maturity, and should be enough to enable both replenishment of the population and a reasonable level of exploitation.”

Page 6. Ref. survival: “Recruit survival is also very strongly related to the availability of microhabitat (see Moore *et al.*, 2012). Actually we have done a more detailed paper but in Indonesian and not peer reviewed. With high microhabitat availability, especially in large sea anemones, there are strong indications survival rate can be much higher than 5-10%, sometimes 50% or more.”

Page 7.

- In 2004 at the same site group size varied from 1 to over 200 individuals (unpublished survey data). Large groups of 50 to over 300 are not uncommon where micro-habitat availability is favourable, e.g. large aggregations of sea urchins. At Bone Baru, *P. kauderni* groups split and reform as the urchin aggregations split or join over periods of hours or days. Larger groups can also form where habitat is greatly reduced, so the fish have to crowd together in/near it. Therefore large group size is not always a positive indicator, and in certain conditions many smaller groups may be the norm or the ideal condition.”
- Our data on recruit habitat and group size from 2004 to 2012 indicate that this is correct for recruits in sea urchin microhabitat but not for recruits in sea anemone habitat, where group size is most often over 20. Our recent paper in Indonesian (still *in press*) covers some aspects of recruit density and group size, but the most recent paper in English on this aspect is Moore *et al.* (2012) which you already have.”
- We also did two surveys in 2012 (June and December). Most of the data are published in some form, mostly in Indonesian, but we have not explicitly written on the group size aspect except for recruits. I do have the original notes and excel files. Although we found a clear reduction in population size, we found groups of over 50 *P. kauderni* at almost all sites, even those with very low overall densities. However as mentioned above this was often because the fish were crowded into the small amount of microhabitat remaining.”

Page 8. Ref. habitat size: “The habitat is quite often more than 10m wide, e.g. at Monsongan the reef flat where *P. kauderni* is found is over 200m wide (shore to reef crest/slope). However it is true that many coastal strips only around 10-30m wide can have substantial *P. kauderni* populations.”

Page 8. Ref. suitable habitat: “Several of these reefs are actually not suitable because they are too exposed, and are unlikely to have had *P. kauderni* populations at least since current geoclimatic conditions were established.”

Page 8. Ref distribution: “I would need to see a map of this to comment. That is not quite how I would describe the distribution, but it could just be a question of how Vagelli expresses the areas. It is unfortunate that I cannot access his book. Where do Bangkurung and Banggai Island fit in this scheme? I recently visited Ambon where there is a research station working on captive breeding. The staff claim to have found Banggai cardinalfish in several other areas of Taliabu and nearby islands. I have not had a chance to check on this. If true, they are unlikely to be introduced populations as the sites are not on BCF/ornamental trade routes.”

Page 9. Ref. Table 1. “It should be noted this is not necessarily an exhaustive list”

Page 10. Delete Manado from introduced populations (also Reviewers #2 and 3)

Page 10.

- Ref. introduced populations: “Introduced populations due to release by traders have also been formed in at least two sites on Peleng Island outside the natural distribution, Lumbi-Lumbia in the west and Bakalang Island in the north, as we found on a visit to these areas in 2013. The ornamental fishermen told us about them, and how they had come about.”
- We have met people who have released BCF in Luwuk harbour, so that whether or not there were any Banggai cardinalfish there originally or not, I am convinced that there have been introductions.”

Page 12. Add mangrove and prop roots to habitat type; coral list is not exhaustive, thus add ‘including’; replace *Tripneustes* sp with ‘other urchins’; Add ‘within sea grass beds than with coral reef and sand/rubble habitat’ “We have a paper in press (in Indonesian, supplied) which includes data on this. Vagelli also mentions mangrove roots. However we only observed adults or large juveniles, no recruits. Indeed recruits would have no shelter in this habitat.” This is not exhaustive, BCF are quite commonly seen in foliose corals of several genera (I have photographs and detailed transect data) and several other corals not mentioned. Perhaps changing **the following corals:** to **corals, including**” “I have never seen Banggai cardinalfish associated with *Tripneustes* sp., and the spines are much too short for even the smallest recruits to take refuge among them. This is a very surprising statement and I would like to know the source(s). However I have frequently seen recruits in other members of the Diadematidea such as *Echinothrix* sp., as mentioned in our attached paper (in press and in Indonesian); suggest replacing with **"and other sea urchins"** “Actually they are found in sea anemones in coral and sandy as well as seagrass habitats. Anywhere there are sea anemones near to *P. kauderni* populations. We have never said they moved between seagrass and sand/rubble etc at that age,

indeed we found no significant ontogenetic shift in habitat but significant shifts in microhabitat use.”

Page 13. Ref. new recruit habitat: “This does not fit well with my observations since 2004. I would question the 2 months of age – I would like to see the data on this. Indeed, we have often seen large groups of all ages in predominantly seagrass habitat, however they were making use of different microhabitat.”

Page 13. Ref. destroyed habitat use: “While this may be correct in some cases, I do not think it is in general a correct interpretation of the observed phenomena in the Banggai Islands. Talking to people (especially older community members) reveals that many decades ago when the reefs were still fairly pristine, *Diadema* urchins were, and had been in living memory, very abundant on most of the Banggai Archipelago. The local names for the Banggai cardinalfish, in several local languages, all approximate to little urchin fish, and many old people can remember playing with them and their host urchins. The patterns of the Banggai cardinalfish are perfect for camouflage among the urchin but poor camouflage in most other environments, including other microhabitats such as corals and sea anemones. The urchins seem to be naturally abundant and may well have been playing a role similar to that reported from the Caribbean in controlling algae, perhaps becoming more important as overfishing of herbivores seems to have begun before the now extensive physical impacts causing degradation of coral reefs. A big problem now is the overconsumption of sea urchins and sea anemones – as discussed in Moore *et al.* (2012) and the attached paper.”

Page 15.

- I attach our paper still in press with an Indonesian peer-reviewed journal. Although I don't have time to translate it now, the data on page 11 indicate that by 2012 the mean observed density was 0.05 fish/m², indicating a decline in the Banggai cardinalfish population to around 62-71% of the estimate by Vagelli in 2005.
- This bay is not comparable to other sites. Of all but one site we have visited, it is by far the most sheltered. In addition, when we surveyed there the density of suitable microhabitat was very high, and there was little suitable habitat for predators such as groupers and other larger reef fish, which would certainly have been heavily fished for the live reef fish trade had they recruited there. At most sites, the best habitat/microhabitat can have Banggai cardinalfish densities similar to or even higher than this, even in very reduced populations, while at sites or in areas within sites where there is little microhabitat even unfished areas do not (and I am fairly certain never did) approach this sort of figure. Even if all fishing stopped, I am sure this site (a pearl farm and live reef fish trade centre, where napoleon wrasse and turtles are commonly among the commodities bought and shipped) would still be the exception rather than the rule.”

Page 16. Ref. Peleng Island population decline: “I am certain this must be a mistake, and probably refers to one particular site on or near Peleng. Peleng is the biggest island with many populations, several of which are still quite numerous, at least compared to that figure, even those which have declined sharply such as the Liang harbour population. This population was unaffected by the tsunami in 2000, but has since been decimated by overharvesting of *Diadema* and sea anemones. We have heard since that a new threat has emerged: feeding Banggai cardinalfish to groupers and other carnivorous fishes being grown out in net cages.”

Page 16. Ref. Liang extirpation: “This was due to habitat destruction, not collecting”

Page 16. Ref. Lembah Strait population: “It would be worth checking that this increase was predominantly due to natural population growth (at least mainly) and not to the subsequent releases as more fish go through Bitung (ornamental trade) and/or diving operations found that tourists liked the Banggai cardinalfish.”

Page 17. Ref. competition with anemonefishes: “There is no evidence from observations since 2004 of any detrimental effects between Banggai cardinalfish and clown fish, who seem to happily share anemones in both the endemic range and in the Palu Bay population. The problems arise for both fishes when the anemones are collected, actually mainly to be eaten though some are collected as ornamentals. Indeed adult clownfish seem to protect all juveniles, their own and Banggai cardinalfish, and the juveniles seem to mix quite happily, often with very high numbers of both species present. However this report would indicate a high capability for population recovery/resilience, at least if conditions are suitable, surprising from this source as Vagelli has been adamant in stressing the lack of resilience/low reproductive rates, in particular during the CITES process in early 2007 (before CoP 14).”

Page 17. Ref. coral reef damage: “Often the craters are much larger than this. Collecting abalone and “sea bamboo” can also destroy even larger areas, with similar or even more intense physical destruction. Coral mining is the worst of all – leaving nothing alive. I am not sure about fungi, as we have not observed this phenomena, but certainly there are creeping sponges and colonial tunicates which can invade such areas and sometimes cover large areas of rubble fields.”

Page 18 Ref. national parks: “There are no national parks or national conservation areas in the Banggai cardinalfish endemic area. The splitting of Banggai Kepulauan into two districts in 2013 has put in question the future of the District MPA which was declared in 2007 and was making slow progress towards implementation. There is at last one village MPA, in Bone Baru; there is supposed to be another on Tolobundu Island, established in 2006 but totally dysfunctional by 2012.”

Page 18. Ref. human population: “Actually human population density is quite high – the most recent census gives 53 people/km² with over 100/km² for some of the key Banggai cardinalfish areas. Most of the population lives on the coast so that coastal strip population densities are probably 3-10 times overall densities. The rate of population increase is also well above the national average.”

Page 18. Ref. crown-of-thorns: “Actually mainly due to overfishing of predators such as napoleon wrasse, tritons etc”

Page 18. Ref. coral reef cover: “It is difficult to relate coral cover directly, as it is not the main microhabitat, and only used by large juveniles/adults. However there is some discussion of the effects due to loss of protection from wave action in the attached paper. For example, on p. 16 the impact of wave action on diadema urchins due to the loss of the protective coral reef barrier and the effects on the BCF sheltering among them is related. To resist the wave action, the urchins lock their spines together to form a flattish dome, a shape with good stability and wave resistance. Any unlinked urchins were just tumbled about and probably would eventually be smashed. All sizes of BCF were forced to crowd under this dome, including the recruits which had been sheltering close to the test, where the spines are too close for adults to penetrate, just dashing out occasionally to catch small prey. This enabled the adult BCF to prey with ease on the smaller recruits, resulting in considerable mortality from cannibalism. Indeed by the time we were forced to leave and regain out boat as conditions continued to worsen, there were very few recruits left.”

Page 19. Ref. warming temperatures: “When collecting data in 2013 for the WPP 714 EAFM study (Ecosystem Approach to Fisheries Management), funded by the WWF and carried out by the STPL (my institution) as the Central Sulawesi EAFM Learning Centre, there were reports of coral bleaching in the Banggai Archipelago from government agencies, corroborated by tales of white coral from fishermen. However these seem to have been of short duration and limited spread. As far as I know there are no survey data or reliable spatial data on coral bleaching in BCF habitat. However we have observed that water temperatures frequently reach 31-32°C during the day in shallow coastal waters with no visible ill effect on corals or other organisms. The 28°C average includes night-time/early morning temperatures.”

Page 19. Ref. sea anemone abundance: “The sea anemone population was temporarily extirpated by a very thorough harvesting event in early 2007. By 2012 there was some recovery of the sea anemone population, though not as abundant as formerly.”

Page 20. Ref. insufficiency of regulations: “There are no local regulations for this harvest, however the regulations on other aspects are indeed insufficient or poorly enforced, if at all. The point made (I hope) is that it would be almost impossible to design any enforceable regulation to

protect sea urchins and sea anemones in the Banggai Islands as a whole. It would not be feasible to list them as endangered species under existing criteria. Perhaps very specific regulations could be made with some chance of enforcement being possible at the village level, e.g. providing protection for specific areas critical for the Banggai cardinalfish (village MPAs or MMAs), which could be supported by District level legislation.”

Page 20. Ref. coral disease: “Is it certain this was a disease? We have observed predation by crown of thorns starfish which often start by eating the tips of these coral species. We have not observed this disease.”

Page 20. Ref. INF export data: “This is too few, I am certain the real figure is higher than this, based on our surveys in 2012 and some observations and information obtained in 2013. This could be referring just to the Banggai cardinalfish from Bone Baru exported through the links set up with support from LINI.”

Page 21. Ref. active villages: “Currently at least 4, as Panapat on Boka Island has re-entered the trade. Of course this does not include the illegal roving fishers from Bali and Java.”

Page 21. Ref. non fished populations: “However populations not or no longer fished are declining as fast as fished ones due to habitat/microhabitat loss, and this only refers to collection by local fishers, again not including the illegal roving fishers from Bali and Java.”

Page 21. Ref. mean catch: “Different figures, but we also found a decline of the same order of magnitude over the period 1999/2000 to 2004 (EC-PREP, 2005 – the Banggai Archipelago section was written by myself and my colleagues, and was published on-line before we had done spell-check or other editing for most of the content, but contains a lot of data and information)”

Page 21. Ref. population exploitation directed fishery: “Unfortunately, the collection of sea bamboo and other habitat destruction not related to the Banggai cardinalfish fishery as well as the consumption of microhabitat have now greatly reduced the *P. kauderni* populations which had previously sustained these quite high levels of periodic collection for more than a decade.”

Page 22. Ref. collection of brooders: “This was the case in 2004 and may still be the case for roving fishers. By 2006 many fishermen had ceased collecting brooding males. In 2011 oversize fish were collected and delivered to Kendari, but the buyer would not pay as he would not be able to sell them on, and released them nearby in the hopes of setting up a local supply for himself. In 2012 we did not find any collection of adults by local fishermen, because the buyers want smaller fish and most fishermen are aware that the future of their livelihood depends on brooding males.”

Page 22. Ref. mortality: “In Bone Baru at least, most Banggai cardinalfish collection has been to order since 2010, greatly reducing the number of fish in holding pens and the time of holding. This is one reason for the sharp drop in mortality reported by fishers in this village, as there is very little time for mortality to occur between capture and being expedited by sea or air to export centres.”

Page 22. Add professional estimate of 400,000 to 600,000 fish collected per year. “This might be possible – but if true would be largely due to the totally illegal roving fishers who are indeed a problem in all fisheries in the area, for food and ornamental fish/invertebrates. I don't believe it is either this high, or as low as 120,000. My "informed guess" would be between 400,000 and 600,000.”

Page 23. Add increase in predation due to habitat destruction; correct the 1995 regulation was not a national regulation. ” This is not correct. The Banggai District – outside the endemic distribution area – has issued such a regulation for all ornamental fishes, and it applies to everyone, including locals. It was not national and cannot possibly be enforced in other districts, i.e. where the Banggai cardinalfish live - apart from the small Luwuk population, to which it does indeed apply.

Page 24.

- And all other species – this is a general law on all cross-boundary movement of fisheries produce, alive, fresh or processed. There is also a quota agreement (15,000 per month, with 5,000 each to Manado, Bali and Jakarta), so that Fish Quarantine certificates are only issued for consignments with a letter of recommendation from the Banggai Cardinalfish Centre (BCFC), officially based in Bone Baru. Fish in violation of the quota have been confiscated and released. The way in which they are released and where is of course also a controversial issue. More information on the LINI website
- Definitely has improved. In 2004 no fish were declared, now at least those from the main Bone Baru fishing village and a substantial number from other local fishers do go through the channels. However the illegal roving fishers obviously do not.” AND “It should be pointed out that the use of poisons and explosives is not in any way connected to the Banggai cardinalfish fishery, and is an external impact from other fisheries”

Page 24 Ref. CITES: “Actually, it was due to the Indonesian Institute for Science, LIPI, who refused to approve the proposal, although all other stakeholders were agreed, from the fishing villages to the Ministry of Marine Affairs and Fisheries. There is still a lot of resentment about this failure, especially at grass roots level. Personally I think it was a tragedy. For years so many people had worked together so hard to get to this point then a few so-called scientists, with very unscientific arguments, just wrecked the whole system which was ready to go. The main argument was that having introduced populations meant the species was no longer endemic

(anywhere) – even though it will clearly always be endemic in the original endemic range – unless extinct there... The paper I have attached is actually on how the Banggai cardinalfish clearly does qualify for "status lindung terbatas" (limited or restricted protection, which seemed then - and still does - a win-win solution), however being in Indonesian and still awaiting printing of the journal in which it is to be printed, I did not sent it to you before.”

Page 24 Ref. CTI-CFF: These are still on paper, but we have hopes they may be able to take over from the now expired Banggai Cardinalfish Action Plan which should have culminated with 2012 seeing the implementation of measures related to the protected status if it had been passed. With the NOAA involvement in EAFM and CTI, perhaps this would be an area for practical collaboration.”

Page 25. Delete reference to tsunami height (also Reviewer #2): “The tsunami was NOT that high, and did not destroy many coral reefs although a few were raised up above sea level and thus died. There was extensive destruction of property and some fatalities. The Banggai cardinalfish population in Liang, one of the worst hit areas, was unaffected by the earthquake. However extensive coral mining to rebuild the jetty resulted in the extirpation of the Banggai cardinalfish population on the two small islands in front of Liang.”

Page. 28. Ref. extirpations: “Bone Baru is being replenished by release of unsold/unsaleable fish on a regular basis. There is also a functioning MPA. It is a special case. Bakakan Island has a very small and declining population according to the Bone Baru fishermen.”

Page 29. Ref. demographic risks: “Bone Baru is being replenished by release of unsold/unsaleable fish on a regular basis. There is also a functioning MPA. It is a special case. Bakakan Island has a very small and declining population according to the Bone Baru fishermen.”

Page 29. Ref. threats to habitat: “I agree overall with this assessment, as though some populations in the endemic range are at a much higher risk than others, and there is a growing risk of serial extirpation as mentioned above, it is not very likely that all populations in the endemic range would be extirpated due to habitat degradation and loss of microhabitat.”

Page 30. Ref. 90% decrease: “There is no real data, but before the consumption of urchins and anemones became widespread, going by the recollections of older local people, it is unlikely the decline was more than at most 50% overall, with a few extreme cases not always related to the ornamental fishery.”

Page 30. Ref. harvest sustainability: “Only if habitat/microhabitat can support this recovery” AND “If the trend in decline of sea urchin and anemones continues, I would predict that

predation, including cannibalism, will become a very real threat and reduce recruit survival to levels well below replacement. However this is most likely considered part of the Habitat threat.”

Page 30. Ref. threats from utilization: “I agree with the conclusion of moderate risk. I agree with the doubt expressed about the beneficial effects of aquaculture in Thailand - or indeed elsewhere.”

Page 30. Ref. disease and predation: “I agree – provided habitat/micro-habitat loss is curtailed. There is a need for vigilance on disease which is very clearly stated in Talbot *et al.* (2013), in particular it is important to prevent the disposal of dead/diseased fish (e.g. from mortality in holding facilities) in ways which could infect wild populations.”

Page 31. Agrees with other natural and manmade factors and overall extinction risk.

Page 31. Ref. CITES: “The way in which the proposal was prepared and submitted was most un conducive to the success of the proposal. There was minimal consultation with CITES authorities in Indonesia and none at all with key stakeholders such as the Ministry of Marine Affairs and Fisheries and the local governments (Province and above all District, let alone any other stakeholders. My colleague Samliok Ndobe and I were suddenly called on to give information and advice at local to national levels, as we seemed to be the only people in Indonesia working on this species at the time (now there are several others) when local and central government fisheries-related agencies suddenly realised that a proposal had been submitted by another country (the USA) about an endemic Indonesian fish. ...” “There were also many other factors, some of which cannot readily be made public domain. In the opinion of many people, including myself and my colleagues, CITES was not necessarily the most appropriate tool under the circumstances at the time, for many reasons.”

Page 32. Ref Coral Triangle: “This is a well-known fact, and was therefore not given a citation in Ndobe *et al.* (2012) but is not based on our work. It would be better to attribute this to an original source. There is an iconic map used by so many organisations, including the CTI, but I can't find where it originated.”

Page 34. Ref. sustainability: “However with the BCF-AP having come to an end and the final steps of a fisheries management plan and the necessary "limited protected status" having failed, there is now an urgent need for a follow-up initiative to maintain gains and carry the process forward. If this does not happen it is very likely that many of the advances made will be lost or reversed. Best to use the past tense – referring to the time of publication.”

Page 34.

- As far as we know the declaration of this MPA was not part of the CTI-CFF, though one factor prompting or influencing the designation was the BCF-AP. As mentioned in note 72, this MPA can no longer legally exist in the original form, due to the split of the Banggai Archipelago into two Districts.
- The Bone Baru MPA is actually working but does not have proper legal status. The Tinakin Laut MPA is now almost impossible to set up by the construction of the new ferry terminal, not envisaged to be in this location at the time of the MPA training and planning.
- For many MPAs it has not yet been implemented. However the guidelines are available to download in Indonesian.”

Page 35. Reference to CBD MPAs and CI and TNC as no longer active or outside scope of Banggai cardinalfish conservation (also Reviewers #2 and 3).

Page 35. Ref INF efforts: “Yes, LINI or INF was doing this, working mainly with Bone Baru fishers and in close cooperation with the Fish Quarantine. As far as I am aware, this came to an end when the funding ran out early in 2013.”

Page 36. Ref. aquaculture: “Whether wild-caught or not, there do need to be greater perceived and/or real benefits of some kind accruing to the people in the endemic area if there is to be widespread support for conservation at community level. Similar considerations apply to government stakeholders, though the appropriate benefits/rewards may be different. Out of the three stated requirements (regulation, enforcement, and certification), the most difficult (and costly in both the short and long term) is likely to be enforcement.”

Reviewer #2 [note does not repeat comments included in Reviewer #1 above]:

Page 4. Ref. mouthbrooding: “The paternal mouthbrooding could be better described, I find “the embryo develops directly into a juvenile” confusing and potentially misleading. Paternal mouthbrooding is typical of cardinalfishes, however the brooding is exceptionally long in the Banggai cardinalfish, enabling the eggs to hatch and the larvae to develop into what appear to be fully formed juveniles before they are released, though I believe Vagelli found that some fin rays are not yet fully formed. On release from the male parent’s buccal pouch there is little if any yolk sac remaining and though they swiftly seek refuge in surrounding microhabitat, they are ready to actively predate small prey.”

Page 4 Ref. average brood: “Males incubate approximately 41 eggs”. Our data give a higher average value (e.g. 59 in Ndobe *et al.* 2013).

Page 6. Add ‘depth’ to ecological barriers; delete the three island groupings as it is confusing

Page 6. : "Its distribution within the Banggai Archipelago tends to form around three island groups": I find this grouping hard to visualise and it does not seem to reflect the distribution which we have observed. I think this may be a case of the terminology used. The populations on Peleng Island are around the southeastern corner and the Liang peninsular. I would not describe this as south-central Peleng. I would like to know which islands are supposed to be in each group. I would consider revising or removing this sentence with the 3 groups, as it could be controversial and in my view does not add anything significant to the content or conclusions of the review.

Page 7. Ref. Table 1: "despite the extensive surveys by Dr Vagelli, this is not proven to be an exhaustive list, I would suggest adding Known (or some similar word) to the title of the table."

Page 8. Figure 2. Change caption to read that cardinalfish are found at several sites within shallow coastal waters; correct several site names. "I would question the phrase "populations occur throughout the island's shallow coastal waters" for the pink islands. For example, Banggai cardinalfish populations are not found on the east coast of Banggai Island or around much of Bokan Island, especially again the east coast (too exposed to the east monsoon). Perhaps it would be more accurate to say that populations occur at several sites within the shallow coastal waters of these islands.

Page 9. Provide new name for Bangkurung

Page 10. Ref. new recruit versus juvenile and adult microhabitat within habitat type (also Reviewer #3). I suggest a rewrite of the sentence: "New recruits (less than 45 days old post release) associate more often with sea anemones within sea grass beds than with coral reef and sand/rubble habitat (Moore et al. 2012; Vagelli 2004, 2011)". My suggestions is: "Recruits and small juveniles associate more often with sea anemones and are rarely found in corals other than *Heliofungia* sp. (Moore *et al.* 2012). New recruits (less than 45 days old post release) associate more often with sea anemones within sea grass beds than with coral reef and sand/rubble habitat (Vagelli 2004, 2011). Vagelli may indeed have observed an ontogenetic shift between seagrass and coral reef habitat. What we have observed is an ontogenetic shift in the use of microhabitat, which seems to occur in all habitats, providing the preferred microhabitat is available. I would like to add a comment regarding the suggestion by Vagelli that seagrass habitats are necessarily more open and that this may be a reason for an ontogenetic shift in habitat. Indeed at Bone Baru the urchins move between the reef crest, reef flat and seagrass, depending on weather and tides (in bad weather they move into the seagrass), and all sizes of associated Banggai cardinalfish tend to move with their host urchins. Therefore depending on the time or day or conditions one would get very different habitat use results from a survey of this site, while micro-habitat associations seem to be much more stable."

Page 11. I question the statement "In areas where coral cover has been destroyed, the black long-spined sea urchin, *Diadema setosum*, becomes prominent and the cardinalfish seeks refuge among these urchins (Lilley 2008)". I consider that this should not be presented in a way which indicates that it is a fact but clearly represented as being the personal opinion of the author (Lilley, 2008). The local names for the Banggai cardinalfish all point to a long history of association with sea urchins. So do the body patterns. It is highly unlikely the association or the names evolved since habitat became degraded. A high urchin density seems to have been a natural state in much of the Banggai Islands. In 2004 urchins were at least as plentiful if not more so in areas with high coral cover as in degraded areas. Urchins are no longer so abundant at many sites due mainly to overharvesting, however at some sites this is also related to loss of protection from wave action due to degradation of the coral reef, the very reverse of the situation as described in the quote from Lilley (2008).

Page 11. the *Diadema* sp. in the final paragraph were very small juveniles, with the spines and part of the test clearly visible. I think this should be made clear that this does not refer to parasitism of host urchins. Adding the word "juvenile" would address this issue, and interested readers could follow up the reference.

Pages 12 through 15. We conducted extensive surveys in 2011 and 2012. These indicated an average density of 0.05 fishes/m², i.e. a decline from the 0.07 to 0.08 quoted by Vagelli. If one accepts Dr Vagelli's estimates for area, then this corresponds to an estimate of around 1.7million. The SE is large. Highest densities (and largest group sizes) occurred in small patches of isolated habitat/micro-habitat where fish were unable to spread out, sometimes due to natural conditions but mostly due to loss of habitat an or microhabitat. All estimates by all authors are based on assumptions with a wide margin for error and/or open to question, and the actual population may be a long way from the estimates. Despite these caveats I strongly believe the declining trend shown by the survey data is accurate. The 0.63/m² density quoted as an estimate of historical density could easily be found or exceeded now, if only considering the patches with high microhabitat density at this or almost any other site. Conversely we could easily produce data giving a much lower density for this site.

Page 14. Ref. human population density: though Lilley (2008) may consider it low compared say to Bali or Java, both much larger and more fertile islands with large urban populations. Indeed human population density is almost certainly at or above the carrying capacity on most of the islands, i.e. without substantial input of resources from outside most islands could not sustain current human populations, particularly in respect of food production. The population growth is also high. For example, on Banggai Island the population has increased by over 30% since the Banggai cardinalfish fishery began. In 2004, division between heirs meant that on average the land owned by most people was insufficient to provide a living, whether from farming or plantation crops, and every year the average plot gets smaller. The further from a major centre one goes, the more goods are sold in small (non biodegradable) packaging, and the more low-

quality plastic bags seem to be used. In addition, there are major shipping lanes and fisheries are a major contributor to certain types of waste mentioned (e.g. styrofoam).

Page 14 Ref. national parks: apart from the Bone Baru community MPA there are no national parks or other MPAs in the area – the District MPA process automatically fell apart when the Archipelago was spilt into two districts, though there are signs each District may revive the program. Therefore the statement about destructive fishing in MPAs is relevant to Indonesia as a whole but not yet applicable to this area

Page 14 Ref. habitat destruction: perhaps there is no truly quantitative information, but we have considerable qualitative information (observations) that where habitat has been degraded in certain ways (e.g. at Tanjung Nggasuang and Toropot in the Boka Archipelago, which we surveyed in 2004 and 2012 and at Mbuang-Mbuang, on Boka Island, surveyed in 2012), large and thriving Banggai cardinalfish populations spread over large areas can be reduced to isolated remnants crowded into small remaining patches of habitat with some protective microhabitat. Typically recruit survival would seem to be very low in these situations, resulting in a mainly adult population.

Page 15. Ref. legislation: it is not correct to say that we believe local regulations to be insufficient now, as there are no regulations, local or otherwise as yet. In the future, any local regulations which might be promulgated (at Village and/or District levels) would indeed be insufficient on their own, and would require awareness raising as well as enforcement.

Page 15-17. Ref. overutilization: I find this section quite confusing with a lot of data, much of which is presented out of context so that it seems more contradictory than it actually is, as the actual parameters measured are often very different. Perhaps some kind of tabulation might help. Overall it is certain that no-one knows for certain the true figures for catch or mortality. There are strong indications that the volume of both has decreased. I am confident the actual volume is substantially less than the most recent communication by Vagelli in 2014 (1 million) but much higher than the trade volume of 120,000/yr reported by Talbot *et al.* (2013). I consider that average mortality is substantially less than the 4/5 quoted from Lilley (2008), but could and should be reduced. The legal harvest (i.e. that which goes through the Fish Quarantine by registered fishers) is arguably now below sustainable levels, however enforcement is weak on both roving fishers (almost all are operating illegally whatever they catch) and traders (those who still don't go through Fish Quarantine), so that illegal, unregulated and unreported capture and trade are still a major problem. In addition externalities are likely to reduce carrying capacity of populations at most sites.

Size of fish harvested (page 17): in 2004, all sizes were harvested (as per the given quote from Vagelli, 2011). Since 2006 that is no longer true, not only due to awareness building but also to buyer pressure. The optimum size and accepted size range have changed over time, and in 2012-2013 the preferred size range was 25-30mm SL. Fishermen were selecting for this size during capture, and specifically avoiding adults, with fish over 35 or under 20mm SL being released at the collection site or at the holding site after refusal by buyers. Brooding males are generally

easy to spot and avoid. Apart from sustainability considerations, fishermen have found that the release of eggs or larvae during transport can result in mass mortality of the captured fish kept in the same bag/container.

Page 16.

- Peleng Island: as can be seen in Figure 2, Peleng is the largest island in the Archipelago, with many Banggai cardinalfish populations. Some of these have indeed declined (e.g. Liang harbour) and one has been extirpated (Liang Island). However this is certainly not the island for which 27 fish remained (according to Vagelli, 2008). I suspect a typing error.
- Liang Island (Ndobe *et al.*, 2013): despite a one-off fishing event reported prior to 2004, there is no doubt that the main cause of this extirpation is habitat loss due to coral mining. The mining continues and the island itself is splitting up due to mining and increased wave action. When it is gone, the harbour will be exposed to the full force of the east monsoon with likely disastrous effects for both the human and Banggai cardinalfish populations in and around the bay.
- Additional notes: (i) there are indications that introduced populations are vulnerable to extirpation. Therefore in my opinion they cannot be considered as an insurance against extinction or as a reason for reduced concern regarding the endemic population; (ii) because of the genetic considerations, I would be very wary of using an introduced population as a source of fish for replenishing or reintroducing declining or extirpated populations in the endemic distribution.

Page 17. Ref. invasive characterization: based on our observations in both the endemic distribution and in Palu Bay: (i) we have not observed any signs of deleterious effects on anemone fish (or other anemone residents such as anemone shrimps) when Banggai cardinalfish use sea anemones as shelter (microhabitat). Adult clownfish seem to protect all juveniles in the anemone (con-specifics and Banggai cardinalfish), and there is no indication of a reduction in clown-fish settlement/juvenile numbers when there are many BCF recruits/juveniles sharing with them. We have not observed any non-anthropogenic spread (colonisation or re-colonisation). My colleagues have been told by diving instructors from the Lembah area that Banggai cardinalfish there have been moved (quite often it would seem) to provide interest for tourists. If this is the case, and is (as seems likely) the main cause of the spread observed, invasive is unlikely to be the correct term. Additional notes: (i) there are indications that introduced populations are vulnerable to extirpation. Therefore in my opinion they cannot be considered as an insurance against extinction or as a reason for reduced concern regarding the endemic population; (ii) because of the genetic considerations, I would be very wary of using an introduced population as a source of fish for replenishing or reintroducing declining or extirpated populations in the endemic distribution.

Page 18. Ref. Inadequacy of existing regulations: The 1995 law mentioned does not apply to the endemic distribution of the Banggai cardinalfish. It is a District level law, only applicable in

Banggai District (Luwuk is the capital city), on the Sulawesi mainland. This was fundamentally misrepresented in the CITES proposal. This mistake should be clarified here. The management of marine and fisheries related matters as a whole is undergoing change in Indonesia, and specifically in this area. By default, in the absence of specific regulations, authority for various aspects of the Banggai cardinalfish fishery and trade and for population and habitat management is spread across many agencies/sub-agencies and levels of government, with considerable overlap and gaps. Some of these are mentioned in this section or later. The Banggai Cardinalfish Action Plan (BCF-AP) from 2007-2012 aimed to provide a regulatory framework. The first attempt was to create a Fisheries Plan (RPP-BCF, failed in 2010 as umbrella legislation was not yet in place). The second approach was to use the provisions for restricted protected status (Status Lindung Terbatas) in 2011, and had widespread stakeholder support (government, fishers, traders, academia, NGOs etc) but failed to become law as it did not get the mandatory support from LIPI, the Indonesian Institute for Science. According to reputable sources, the main argument used to oppose the proposed law was that the introduced populations meant the species was no longer endemic, even in the endemic distribution, a position I consider unscientific. There is now a policy vacuum, as the BCF-AP (with the associated central government personnel and funds) has now expired. The CTI-NPOA (drafted in 2009 for the period to 2012) component on the Banggai cardinalfish has not yet been put into practice. The delays and extensions associated with this plan may actually have a positive result as they mean there is still a chance for the CTI-CFF to implement the Banggai cardinalfish component as part of moving towards EAFM. There is no mention here of the quota mechanism or the Banggai Cardinalfish Centre (BCFC). I feel they should be at least mentioned at this point.

Reviewer #3:

Page 3: Technically, a fish's brood pouch refers to a "marsupium" type of cavity where eggs/free embryos are incubated (e.g., syngnathiforms). In *P. kauderni*, as in all apogonids, incubation occurs in the oral cavity (mouthbrooder).

Page 4. 6 mm is the size at hatching; at release recruits measure ~8 mm (Vagelli, 1999, 2004, 2011). Juveniles are defined as individuals that did not reach sexual maturity. In the wild, females mature at ~ 40mm SL (Vagelli, 2011).

Juveniles are defined as individuals that did not reach sexual maturity. In the wild, females mature at ~ 40mm SL (Vagelli, 2011)

Page 5.

- It is well known that during incubation *P. kauderni* (and all studied apogonids) do not feed (they can't) during incubation. The only instance in which food items could be found in the stomach of a brooding male is if the male was captured just a few hours after mating (beginning of incubation) and not enough time had passed for the digestion of the last feeding to have been completed.

- 500 potential offspring over its lifespan is possible. However, this statement seems to imply that *P. kauderni* is a monogamous species (it is not). A more accurate description would be that a male (in this species, males limit the reproductive output) can incubate/brood a maximum of ~ 640 offspring over his lifespan. This calculation assumes 16 brooding events over 2 years of continuous breeding; an average brood of 40 new recruits released; and a reproductive cycle of 25-28 days of brooding; 20 days of recuperating-feeding/new pair formation/mating. Of course, this implies that the male always encounters and accepts a sexually mature female when he is ready to mate, and that the mating/egg transfer every time is completed successfully (e.g., without inter/intraspecific interference during the courtship /isolation period, female predation, etc.). A more realistic number is likely to be about 400 new recruits/male. Mortality after the first week post-recruitment is likely to be ~ 90% (Vagelli, 2007). Survival to adulthood is probably <5% /brood.

Page 6. A more accurate statement would be that new recruits (NR) are found more often associated with anemones...than with seurchins in reef habitats. Thus, the observed differential utilization of hosts and habitats does not necessarily imply that NR actively choose their recruitment habitat/substrate. Further studies are required to determine the role of post-settlement processes involved in this ontogenetic shift, including the extent of potential intraspecific competition, passive migration between zones and differential predation pressures (Vagelli, 2011). However, it is likely that the observed habitat-microhabitat segregation is mainly due to a differential survival, i.e., NR suffer lower mortality (predation) when they are associated with anemones than when associated with sea urchins.

Page 10. To date, no observations suggest any active displacement of NR (or any size class) from one type of substrate and or habitat to another type in order to avoid predation by conspecifics.

Page 11.

- If original local groups of *P. kauderni* survive the degradation of their coral reef habitat, and if seurchins happen to remain in that area (e.g. due to increase in algal cover), then the fish may stay associated to the urchins (since they are likely the only available protective substrates). Similarly, if groups inhabiting a coastal area (typically a seagrass bed, not a coral reef) are exposed to foreign materials originating from a villagers settlement, the fish will utilize those objects as hidden/protective substrates. This, however, does not imply that this species can adapt to poor environmental conditions. In addition, those foreign elements (similarly to natural living substrates) possess a particular “carry capacity”. In other words, there is a limit to how many fish can safely seek protection in a given object.
- The report of these highly implausible prey items is most likely a product of incorrect taxonomic identification and/or a flawed methods used for analysis of feeding behavior. See Vagelli (2005, 2011) for an in-depth analysis of *P. kauderni* feeding habits and Vagelli (2002) for a more general description.

Page 12.

- The detailed mapping of the BC geographic distribution within the archipelago involved over 190 sites on 64 islands and 5 reefs (Vagelli, 2011). The number of sites (and islands) where population surveys (censuses) were conducted by the reviewer increased in every expedition. However, the latest surveys always included census of all sites previously censused. Thus, it was indeed a density comparison of specific sites overtime. For instance, the sites where censuses were conducted in 2001 were surveyed again in 2002, 2004 and 2007 (Vagelli, 2005; 2008).
- In 2007, a much-unexpected finding was the decline in abundance of the mentioned “Pearl Farm” population, which has been used as baseline. The latest census showed a density of 0.47 individuals m² (in 2004 was 0.58/m²). The farm’s owner stated that in 2006 fishers began collecting *P. kauderni* in rapid incursions inside the bay. Although the bay is under surveillance, there are two blind sites from where fishers are able to enter without being immediately detected. It appears that “poaching” is still occurring (Talbot et al., 2013). The capture of *P. kauderni* in this site, even if less significant than in the rest of the archipelago, is an unfortunate development because the “Pearl Farm” site has been the only available reference site to compare the degree of decline of this species due to human intervention (Vagelli, 2007).
- A better appreciation of the conservation status of this species, and the actual meaning in terms of population abundance and its fluctuations can be described by transforming the density data into actual numbers of individuals composing the populations. Thus, the observed doubling in density of that population might seem to be a very significant improvement on its conservation situation. However, this doubling in density represents an increase from 144 to 288 individuals encountered in that census site. The addition of ~150 fish in a three-year period is clearly a very small increase, which can easily be reversed even by stochastic environmental processes, as demonstrated by the (cited) census completed in 2007.

Page 13. This, as well as most other introduced populations, with the exception of Lembeh, is a small population of a few hundred individuals. In this case the species is confined within the harbor, an area of ~ 0.6 km². In 2007, it showed a dramatic decline in abundance in comparison with 2004.

Page 15.

- Water temperature (measured by the reviewer) in most sites inhabited by *P. kauderni* ranged between 29-31oC, but in 2004, 34 oC was recorded in a few sites. This high temperature would exacerbate the impact of ocean warming on those coral reefs habitats.
- *P. kauderni* entered the ornamental fish trade after its discovery and posterior introduction to the aquarium/hobbyist community in 1995 (Allen & Steene, 1995; Marini & Vagelli, 2007)

Page 16.

- Overall, it is the reviewer’s opinion that the credibility of the data included in these reports is at best questionable. For instance, neither the 2008 capture data from Bone Bone (one of the main collection centers) was not documented, nor was the Panapat data for 2008-2009, (where other main collection center [“Bokan”] is located). These two collection centers reported a minimum monthly collection of ~15.000 fish in 2007

(Vagelli, 2008, 2011). Moreover, in the same works, absolutely unrealistic mortality rates obtained from the local Fisheries Agencies (2.0% for 2008 and 0.3% for 2009) are presented as trusted figures, with the only comment that “Observation and anecdotal information indicate there may be some under-reporting of rejects (often released near to the fishing villages) and mortality”.

- No source for this data is given in the cited reference. US customs??
- This statement is not accurate. In Talbot et al. (2013) it is not clear who, among the “multi-stakeholder group” that includes LINI, provided the 120.000 figure. Rather it is likely that it was originated by the local “Fish Quarantine and Inspection Agency”, which, as far as it is known, is the only institution that has been cited keeping some BC trade statistics.
- The suggestion of a reduction in active participants in the Banggai cardinalfish trade is not well supported, and using the number of villages involved in such trade may be misleading (particularly if neither villages west to the Bokan group are not included, nor the fishers that comes from outside the Archipelago). A more representative measure would be the number of active collectors. In 2001, there were about 130 actively (i.e., at least 1-7 days/week) capturing *P. kauderni* (Lunn & Moreau, 2004). By 2007 ~ 80 collectors operated from three main collection centers (which are still active) (Vagelli, 2011), and all indicates that by 2012 there still remained about the same number.
- This statement is inaccurate, and likely due to the confusing and partial information provided on the cited work. For instance, in Table 2 (Moore et al., 2011) Mbuang-Mbuang is categorized as a village “Not Active” in collection since 2004. However, the authors state that “*In 2008, the villages monitored were Bone Baru, Toropot and Mbuang-Mbuang. However, as in 2004 Mbuang-Mbuang was actually a fishing ground (for Panapat fishers working with Balinese roving collectors), not a P. kauderni fishing village (Ndobe et al., 2005), it is not surprising that there were no fish collected in the data for this village*”. In other words, collection indeed took place in Mbuang-Mbuang island (=Buang-Buang, see Vagelli, 2011) and adjacent areas, but collection data was not gathered. Moreover, in Table 2, “Panapat” is categorized as a “Possible Active” fishing village, and as it was mentioned (LN #549) it is part of Bokan main collection center. In addition, trade and population surveys conducted by Yahya et al.(2012) shows that one of the areas under higher collection pressure until 2012 has been Toropot , which is also part of Bokan main collection center (Vagelli, 2008, 2011). Furthermore, collection activities on areas east to Bokan, including Tempaus, Massoni, Limbo and Seku Islands are not included in those reports. Thus, the notion of a late significant decrease on the spatial extent of fishing grounds is not supported.
- More accurately, US imports in 2009 were 11% lower than in 2005 (no import data is available for 2006-8). However, Talbot et al. (2013) point out that during the global economic recession a decrease of ~10% imports of *P. kauderni* to USA. However, imports of *P. kauderni* remained stronger than almost all species imported into USA through 2009, which decreased 25% across the board, and hence, the authors considered that during that period *P. kauderni* imports have actually increased relative to imports of other species.
- No data whatsoever is provided about this facility, including specific location, current/expected production volume, present operational status, etc. In fact, extensive internet searchers failed to localize any information about any aquaculture

facility/exporter of *P. kauderni* in Thailand. In addition, neither the Royal Thai Consulate in USA, nor the Thai Trade Center were able to confirm the existence of the mentioned aquaculture facility. This significant claim should be either removed or supported with specific information.

- This statement seems to imply that currently there are captive bred operations in the US. However, the supporting references only relate to technical advice on captive breeding and production of *P. kauderni*, and encouragement/pleas to do so.

Page 17. According to the cited works, mortality $< 1\%$ is data collected by BRKP/MFS in all main trade centers for 2009 without any specification regarding where it occurs (i.e., collection, holding, shipping), and implies that in fact it represents overall trade mortality. Thus, this absolutely unrealistic information should not be included, unless for emphasizing the unreliable nature of trade statistics provided by the mentioned agencies, and the other information reported by the authors.

Page 19. The indiscriminate removal of hosts (harvesting of anemones) adds to the degradation of living substrates, critical for the survival of *P. kauderni*, due to the widespread use of blast fishing and cyanide. It is important to realize that these populations are quite small, probably no more than several hundred individuals and restricted to enclosed bays harbors.

Page 20. The reviewer strongly agrees with this statement (see also Vagelli, 20011, Ch.13).

Page 21. Leading to a high degree of genetic differentiation. Pair formation (and isolation) and prolonged courtship/mating behaviors

Page 22. See comments in response to reviewer charge

- the 120.000s figure probably derives from the local “Fish Quarantine and Inspection Agency”, which, as it was acknowledged in all works citing its data, is not representative of the true magnitude of the collection of *P. kauderni*, given that the vast majority of its trade is not reported to that agency. For instance, Yahya et al. (2012), state that “*Harvest data from only one location (Bone Baru) showed that, in 2010 and 2011, 99,898 and 99,719 (respectively) BCF shipped to major cities in Indonesia for distribution internationally. There are a number of other gateways within Banggai Islands and throughout Indonesia through which BCF have been sent from Banggai to the international market, but trade figures from these gateways remain unreported*”. In addition, this (clearly unrealistic) 120.000 number only refers to trade data, not collection, i.e., it does not include mortality associated with collection/trade (as the 1000.000 figure does).
- More importantly, lacks dispersal ability, which restricts any meaningful displacement in new recruits, juveniles and adults.
- It remained pristine until 2006
- Not sure what “stabilized” means in this context. A population that contained 6,000 fish in 2001 (0.02 fish/m²) was reduced to 17 individuals in 2004, and only four fish were uncovered within the census area in 2007. In 2007, a total of ~350 individuals remained in both Bakakan Islands. Today, it is possible this population may be extinct.
- hence compromising the species’ long-term persistent and evolutionary processes.

Page 23. See comments for Page 16 and 17 above.

- There exists ample evidence that *P. kauderni* was “rediscovered” in 1994 and introduced to the aquarium community in late 1995 (e.g., Allen & Steene, 1995; Michael, 1996, Marini & Vagelli, 2007). Despite some erroneous reports, the capture of this species did not begin before its discovery. Moreover, the mentioned date of 1980’s as the starting point of *P. kauderni* trade that appears in works cited in the present Draft Review (e.g., Moore et al., 2011; Ndobe et al., 2012) is quoted from Ndobe et al. (2005). However, in Ndobe et al. (2005) what is stated starting in the 1980’s is the ornamental fish trade in the region, not the Banggai cardinalfish trade, which, in fact, is stated to have begun “in the 1990’s” . The earliest cited year for the beginning of *P. kauderni*’s trade was in fact 1995 (one village), and most villages were cited beginning such trade in 1998-1999 (Ndobe et al., 2005; pp.180).
- This statement does not seem to be supported by the data, evaluation period, and methods of included references. In addition, the trade volume of *P. kauderni* includes the number of specimens exported to/imported into all the main markets (USA, Europe, Asia).
- No data is provided regarding volume of exports of Banggai cardinalfish from this alleged aquaculture facility. In fact, there is no evidence of its current/future operation.

Page 24. There is no concrete evidence supporting that in the foreseeable future the trade may become sustainable. In fact, it seems much more likely that a sustainable trade will neither be attained in the near future, nor before the eradication of other populations (DPS). This conclusion is based on the unfulfilled commitments and assurances that CITES Indonesia made in 2007 at the COP 14, as well other subsequent plights put forward by local and regional offices regarding conservation plans bearing specific goals and deadlines. For instance, Moore et al. (2011) state “Some of the monitoring activities only began recently (e.g. specific *P. kauderni* records kept by the Fish Quarantine). Others now appear to have ceased, e.g. the monitoring by local enumerators from the District Marine and Fisheries Service (MFS) and fishing communities backed by the Ministry for Marine Affaires and Fisheries (MMAF) Marine and Fisheries Research Agency (BRKP). Some have been undertaken on an irregular basis, often depending on the current availability of financial support”. Moreover, the reports describing conservation efforts toward *P. kauderni* cited on this Draft (and most likely the only ones available) evidence the absence of any strategic plan and financial support for a comprehensive conservation plan directed to protect this species. Furthermore, the credibility of the mentioned reports regarding the actual conservation work being implemented is weakened by the inaccuracy in which information is presented, and by the seemingly unfamiliarity with some aspects the natural history of *P. kauderni*. For instance, Moore et al. (2011) included Vagelli (2008) to describe fishing activities over 2001-2011 period. However, the main capture center (and associated fishing grounds) located in Bokan and reported by Vagelli (2008), is only described as “Possible Active” in 2006-2008/9.

Page 25.

- It is not clear what legal status means, and its significance, since the capture of *P. kauderni* is a legal activity within the Archipelago.

- Avoiding the capture of brooding males by this fisher group (probably no more than 10 people) is presented as the only concrete example of improved/ing capture sustainability. However, no description is given on the technique utilized to avoid their capture. Taking into consideration the equipment and technique typically utilized for capturing *P. kauderni* (including in Bone Baru) (see Vagelli, 2011), avoiding the capture of brooding males is more difficult than it seems. Furthermore, once a brooding male is netted, the most likely outcome is that it will expel the eggs/juveniles. Hence, after their capture it will be very difficult for an untrained eye to determine whether some fish were indeed brooding.
- The cited work reports that the volume of legal trade (i.e., the number of specimens leaving the Archipelago being reported to the local Fish Quarantine office) was: ~83000 in 2008; 216.000 in 2009; 149.000 in 2010, and ~57.000 (6 months 2011). These numbers not only are significantly below the capture volumes reported by the “BCF enumerators”, but more importantly, they show that the “legal trade” represents only a minimum component of the estimated annual capture of ~ 900.000 specimens.
- There is no evidence for that (ref. improved monitoring and enforcement).

Page 26. See comments Page 24 above;

- The reviewer already expressed his skepticism about the authors’ conclusions that *P. kauderni*’ fishery is well on the way of becoming sustainable, as well as on the reduction on “destructive practices -the only provided example is collection of brooding males- and mortality. In addition, it is the reviewer’s opinion that such a crucial claim about the conservation prospects of this species should only be included if it is supported with significant- peer-reviewed quantitative data on capture/trade and population status over the entire range of the species for a meaningful period of time. However, in the cited work not only is such data not included, but the authors also concede that “*most monitoring has been and still is irregular..., with no overall strategy/plan and there is a lack of coordination between organizations*” ...and “*There has been no common agreement on methods/protocols, and activities undertaken not always truly “monitoring”....“there is still a lack of some important baseline data (e.g., limited spatial coverage)*”.
- This statement is incorrect. According to the cited work, the mentioned MPA consisting on 10 islands was “declared” (not established) in 2007 (by 2012 it was still in the “planning phase”). The CTI-CFF dates from 2009 (the conservation of *P. kauderni* is one of its goals, but no specific MPA is included for its conservation). In addition, in the same work, the authors state that only two of those 10 islands “*are designated specifically for the conservation of the Banggai cardinalfish*” (and one of those two, Togong Lantang does not harbor the species for which supposedly was designated to protect). Further, the authors recognize that “*Based on currently available data, the District MPA network design is poor from P. kauderni population and genetic diversity aspects.*”, “*The vast majority of the known P. kauderni and most of the known genetic diversity are outside the MPA boundaries*”.

- In fact, *P. kauderni* is absent from 5 of the 10 islands designed to establish MPAs, all which clearly exemplifies the absence of a coordinated well supported strategic plan designated for the protection and sustainable exploitation of *P. kauderni*, as pointed out on LN #829. Furthermore, the described MPA planning reinforces the skepticism expressed by the reviewer regarding actual conservation actions and improvements in sustainability claimed in the works cited in this section, as well as on the overall accuracy of reported data.
- The assertion that some of the MPAs are within the Banggai Archipelago needs supporting evidence. In the cited work there is no specification of where those MAPs are located within Indonesia.
- This statement could imply that application of the mentioned MAC standards, training of collectors/officials and reef restoration included activities that took place in the Banggai region, which did not. The reported LINI activities described by Lilley (2008) in the Banggai region were a short (10 days), circumscribed (five sites), general assessment of the capture and trade of *P. kauderni*, on socioeconomic aspects of local people, and some surveys “short transects” (snorkel) to “provide a rough estimate of *P. kauderni*’ abundance.

Page 27.

- The assertion that the alleged “INF’s training and education efforts have positively benefited the Banggai cardinalfish”, seems, at best, an enormous overstatement. According to the cited reference (Talbot et al. 2013), the authors mentioned that a “more benign collection methods” (i.e., using the “loop net” instead of the “cang net”) was observed only in one site (Bone Baru) where one fisher stated that in that site collectors “do not commonly use the cang net anymore”. Furthermore, no data whatsoever is provided to illustrate, even for that site, in which specific way the species is being benefited by this collecting net (whose utilization was observed by the reviewer without any apparent difference in terms of selectivity).
- It is unclear how this statement relates to the status review of *P. kauderni*, and it is advised not to be included. The cited work is a detailed analysis of marine hotspots, mainly based on coral reef fishes, with the goal of aiding in the prioritization of marine conservation initiatives, particularly in the Indopacific. In this study, the author recommended focusing on 14 marine areas (identified as key endemic areas) for of creating MPA networks. However, none of those areas include the Banggai Archipelago. Thus, this statement might seem to imply that according to Allen (2008) CI-TNC has conservation projects/plans designated to protect areas/species within the Banggai region, which is not the case. Moreover, as far it is known, no such plans exist (despite CI having supported the 1998 RAP assessments conducted by Allen in the Toggeans/ Banggai islands).